A New Approach for More Effective Fire Detection Method Using NOAA AVHRR Images

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***Abstract* - Forest Fire has serious economic implications: destruction of habitats, forest damage, costs of fire fighting and so on. Nowadays it is very important and sensitive issue in Russia and Southeast Asian region since a large scale fire occurs frequently. A huge amount of exhaustion of carbon dioxide by the forest fires thought to be a cause of global warming. A wide range monitoring by remote sensing satellite is indispensable for the grasp of the fire occurrence situation. The Advanced Very High Resolution Radiometer (AVHRR) flown on the NOAA satellite series is one of the best systems for fire monitoring due to the combination of a very good temporal resolution of several images a day. The forest fire analysis using this weather satellite NOAA has been done by various researchers. However a lot of problems have been left and existing fire detection methods are insufficient. Moreover, a real time fire detection method is necessary for early warning and early detection of fire for fire fighting. In this work a new fire detection method using NOAA AVHRR images have been constructed.**

I. INTRODUCTION

Four fire detection methods proposed by Flasse et. al. [1], Boles et. al. [2], Nakayama et. al. [3] and Kudoh et. al. [4]. have been studied using NOAA AVHRR images for Sakhalin and Japan region. We compared the fundamental differences, problems and effectiveness of these early fire detection methods. These early methods adequately detected the actual fire but a large number of false detection is also included. In most of the cases it is found that false detection occurred at the position where the temperature of Ch3 rises by reflecting sunlight on sea. In Kudoh's method false detection also happened in the part where Ch3 temperature is very high by seasonal factor. Considering the drawbacks of these early methods a new algorithm has been proposed here.

II. COMPARISON AND PROBLEM FINDING IN EARLY METHODS

The detection methods are applied to two different regions, Sakhalin and Japan. The result of each method is compared. It was verified that the accuracy of the fire detection method is greatly dependent on the temperature of Ch3. In the graph of Figure-1 shows the comparison of detected fire points for each method applied in Japan region in July 7, 2004. The fire

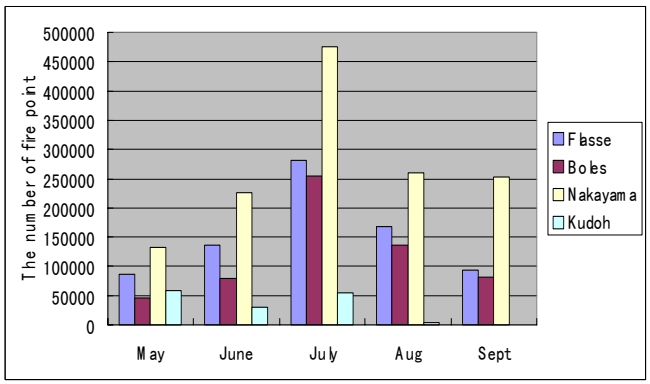

Figure-1: comparison of detected fire points for each method in Japan region in July 7, 2004

that observed with NOAA in the graph has hardly happened in Japan. The temperature of Ch3 fluctuates largely with the change of temperature with latitude and season. Especially very high brightness temperature is shown in the part where the desert and the vegetation are low in summer or with the reflection of solar light from sea. We presumed that the accuracy of fire detection may go up if these problems can be removed. It is found that the least false detection happened in Kudoh's method. We proposed a new fire detection method by improving the Kudoh et. al. technique with decreasing the false detection using time series analysis.

III. PROPOSED FIRE DETECTION METHOD

First of all, it is thought that the false detection can be decreased by specifying the region where the possibility of fire occurrence is present such as forest, by using NDVI (as well as used in Boles et. al. method). The possibility of the false detection by the reflection of the sun light on the sea will be reduced. Moreover, when the brightness temperature of Ch3 rises by season, it is thought that the fire can be understood depending on the target change during that time by statistical time series analysis. Especially, when the brightness temperature of Ch3 rises at the season it goes up gradually whether the rise goes up suddenly for a fire.

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14. ABSTRACT

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Figure-2 shows the flow chart of proposed method. Received AVHRR data corrects precise geometry [5]. In our proposed method first the region with the possibility of the fire occurrence is specified by Fuel Mask algorithm of Boles at el. [2]. The false detection places (such as deserts and seas) to

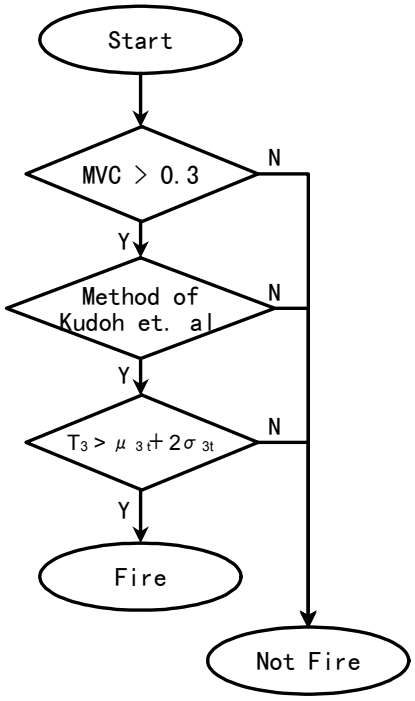


Figure-2: Flow chart of proposed method

which it comparatively rises the temperature of Ch3 is removed by considering the MVC (Maximum Value Composite). MVC is assumed as the highest value of NDVI (Normalized Deference Vegetation Index) during past one month. Next the fire points are detected by Kudoh's method [4]. The 14 years forest fires points were accumulate in a three dimensional histogram in Far East Russia region. The

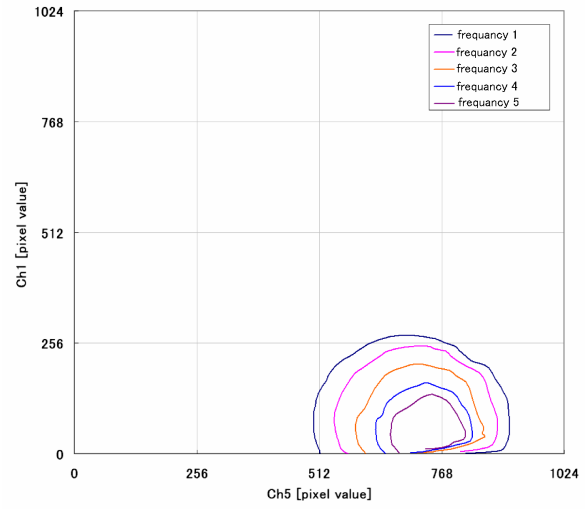


Figure -3: The fire category in Two Dimensional Histogram

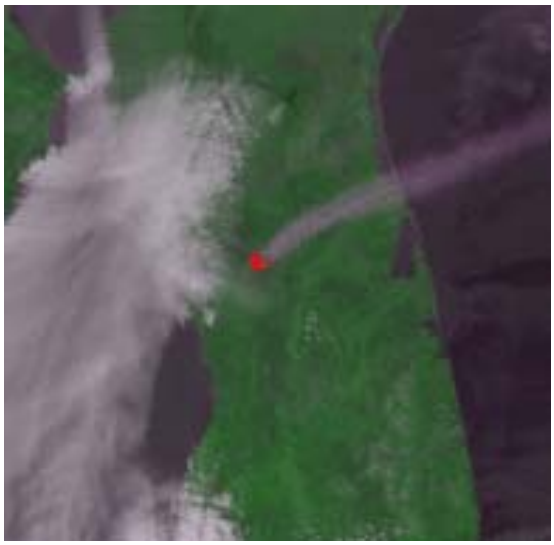
combination channels were Ch1, Ch3 and Ch5. The result shows almost all the Ch3 values were saturated. So, Two Dimensional Histogram composed on Ch1 and Ch5 is obtained, which provides reliable fire detection corresponding to occurrence number of the histogram. This makes some looped area in the histogram. The valuation shows that the area over 5 of the occurrence number in the histogram detected the fire for another region images without errors.

Figure 3 shows the results of fire detection areas with Ch1 and Ch5 AVHRR images. As the three dimensional histogram, the plane of Ch3 has saturated, the circles corresponding to occurrence numbers in Figure-3 are represent the fire category.

After that a time series analysis is done over those fire points to remove the false detection due to the rises of thermal radiation of Ch3 by seasonal factor, other than by a fire. In time series analysis a statistical process has been performed and the fire points of past 20 days from the target day is used as threshold.

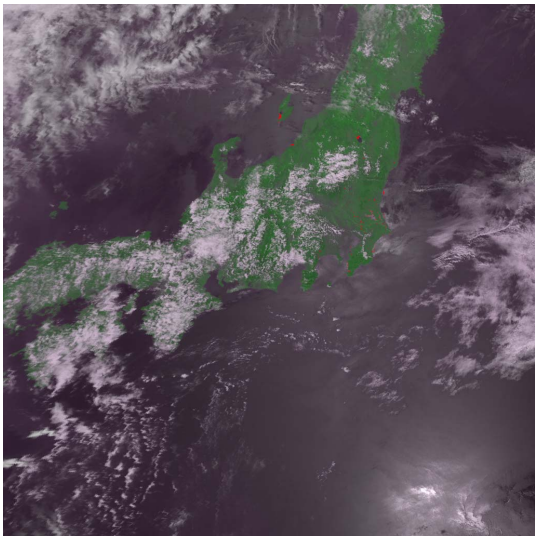
IV. APPILCATION OF PROPOSED METHOD

The method is applied in Sakhalin and Japan region to detect the fire and the results are compared with the results of Kudoh's method. The Figure-4 and Figure-5 show the image of the detection results for proposed algorithm in Sakhalin



Figure–4: The result of proposed method in Sakhalin on June 17, 2003

and Japan region, respectively. The same images have been used as it was used before in the comparison on early methods. This method makes fire detection much more effective than previous methods and the number of false detection has decreased greatly without compromising the degree of



Figure–5: The result of proposed method in Japan on July 7, 2004

accuracy. This method is applied to a real time forest fire monitoring system using NOAA AVHRR image for Northeast Asian region [6].

V. RESULTS

Figure-6 shows the graph of comparison between Kudoh's and our proposed method for fire detection points in Sakhalin

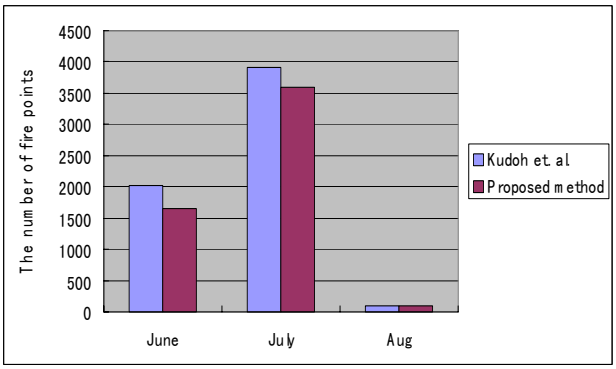


Figure-6: Comparison of the fire points in Sakhalin region in 2003

in 2003. From this figure it is clear that the proposed method detected the fire for Sakhalin in the same degree as it is detected by Kudoh's method. Figure-7 shows the comparison between Kudoh's and our proposed method for fire detection

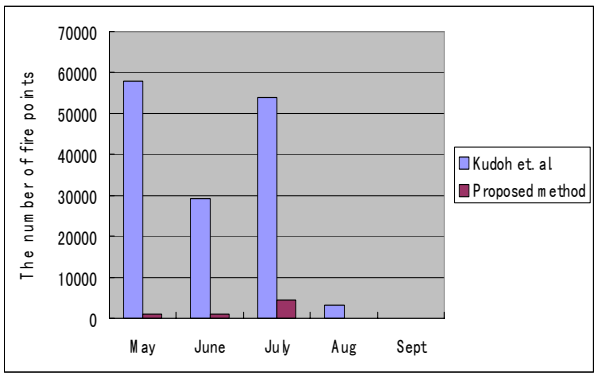


Figure-7: Comparison of the fire points in Japan region in 2004

points for Japan region in 2004. The fire points as shown in Figure-7 were actually false fire points, no fires were occurred in Japan that time. So it is clear that in our proposed method the number of false fire points has decreased greatly in the comparison to Kudoh's method.

VI. CONCLUSION

In this work we have been constructed a new fire detection method using NOAA AVHRR images. Our method detected the fire with the degree of high accuracy. Moreover it reduced the number of false detection though the false fire detection happened very few. A future subject is to find out the cause of these few false fire points for further improved fire detection and to calculate the burned area more accurately.

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